NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ESDS Reuse Working Group

Software Reuse Practices Within the Earth Science Community

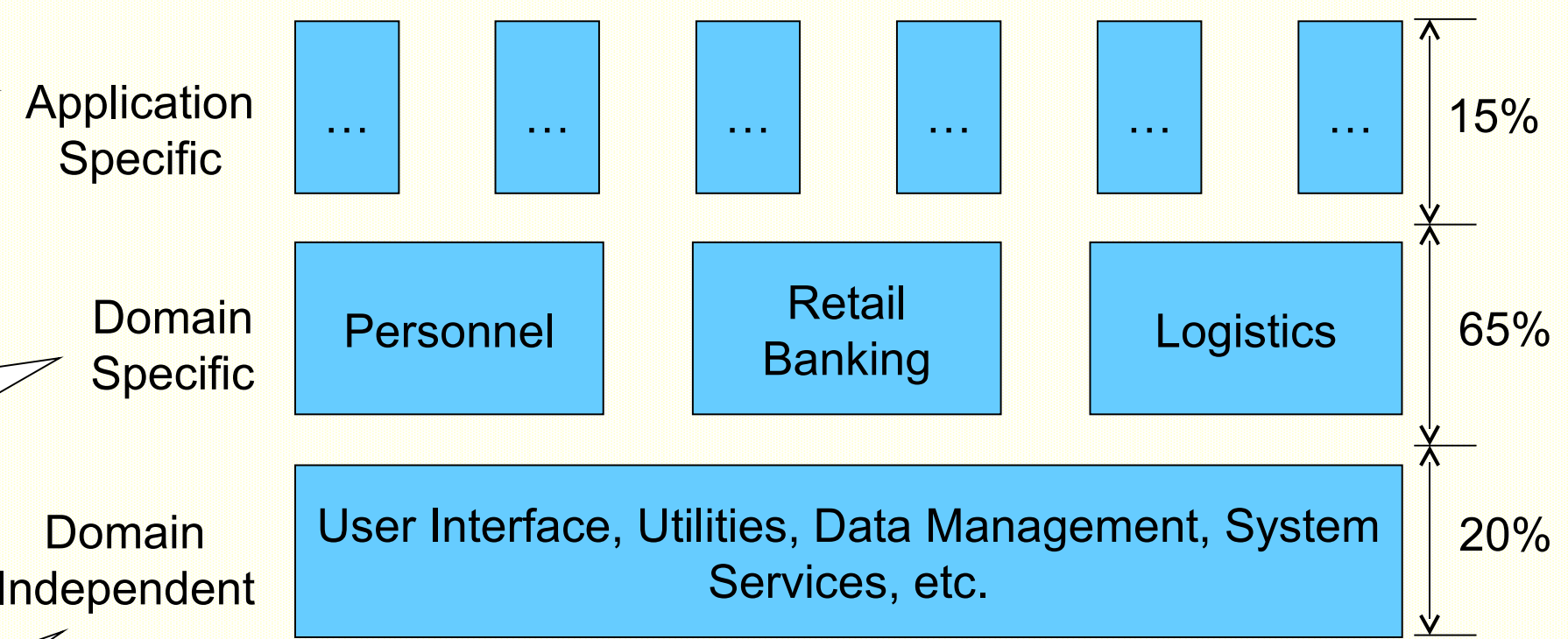**Authors: Olding, S W, Delnore, V E, Samadi, S, Wolfe, R E**

Software reuse is the process of implementing or updating software systems using pre-existing software assets

Reusable assets can be from any part of the software development life cycle including: software components, objects, software requirement analysis and design models, domain architectures, database schemas, code documentation, test scenarios, and plans

Expected Benefits of Reuse
- Lower development costs
- Higher productivity; better use of resources
- Reduce cycle time; quicker development
- Lower training costs
- Easier maintenance
- Higher quality
- Lower risk
- Better interoperability

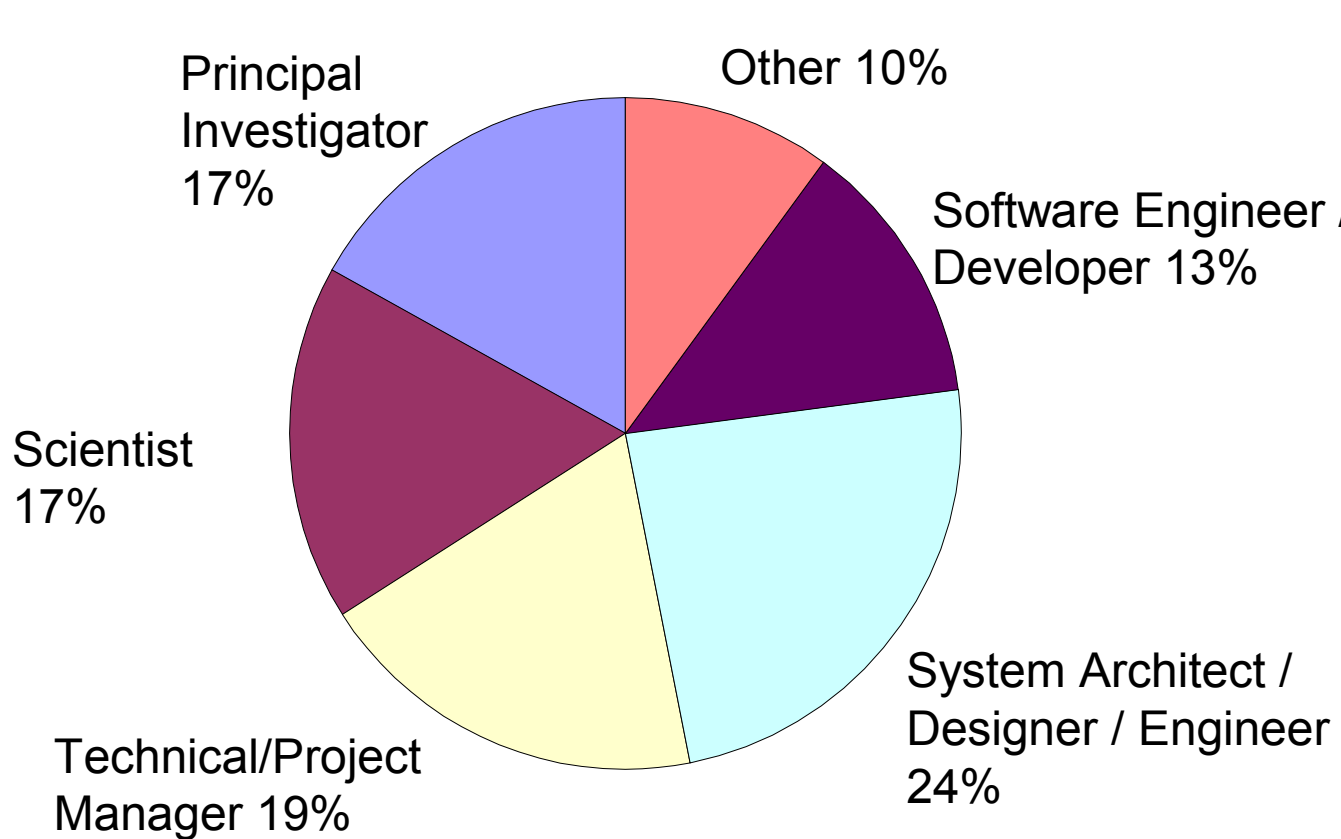### The composition of a 'typical' application...

The 'application specific' layer represents software which is unique to a particular application. This is not software that can be reused.

The 'domain specific' layer represents software that is specific to a particular business area, e.g. a Earth science missions. Software in this layer has the potential to be reused across similar types of systems.

Reuse in the 'domain independent' layer usually comes from commercial off-the-shelf (COTS) components and public open source software.

Layer	Content	%
Application Specific	... ...	15%
Domain Specific	Personnel, Retail Banking, Logistics	65%
Domain Independent	User Interface, Utilities, Data Management, System Services, etc.	20%

... a theoretical reuse potential of up to 85% of new application development.

Source: Jeffery S. Poulin, "Measuring Software Reuse"

Survey conducted to establish reuse practices and needs of the Earth science community

OMB approval obtained 01/04/2005 (Approval No.: 2700-0117)
Used Web-based survey tool (Vanguard Vista) to simplify response submission and data collection
Approximately 3000 invitations issued – 100 responses
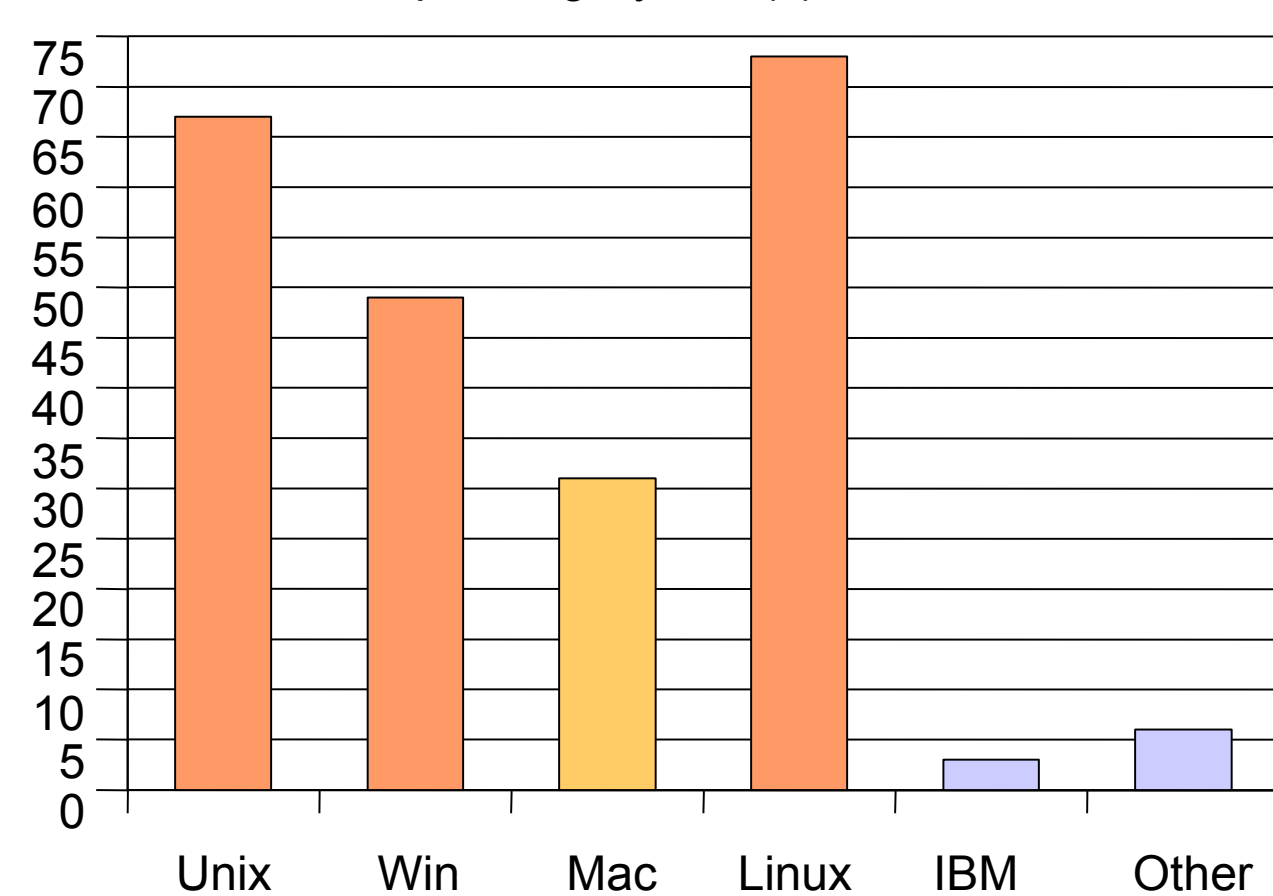
Reuse Survey – Community Profile

Which of the following best describes your main role in your project/software development process?
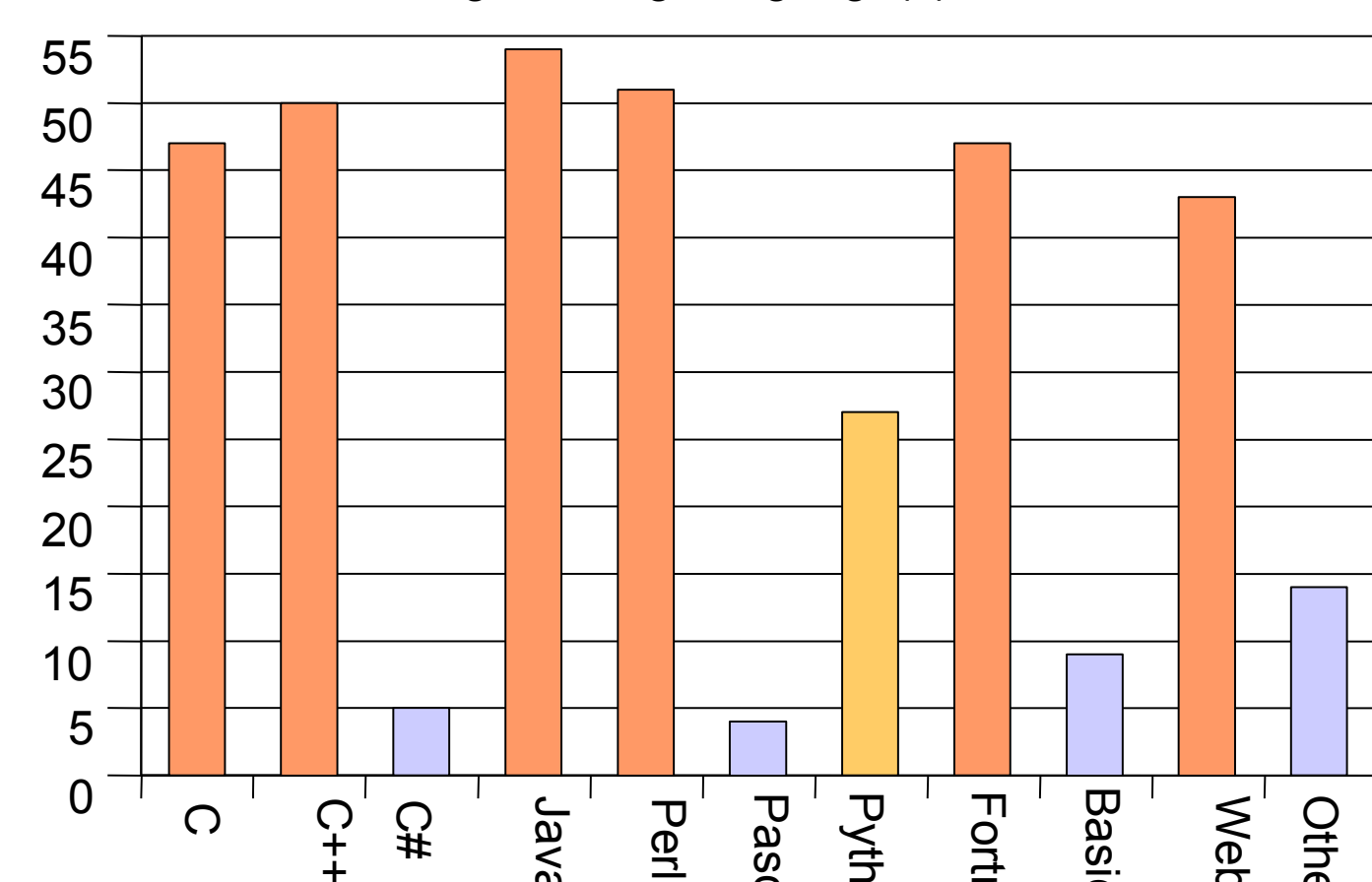- Principal Investigator 17%
- Other 10%
- Software Engineer / Developer 13%
- Scientist 17%
- System Architect / Designer / Engineer 24%
- Technical/Project Manager 19%

Which category best describes the type of your organization?
- Other 3%
- Commercial Organization 14%
- NASA 46%
- University / Academia 23%
- Other Government Agency - 14%

Operating System(s) Used: Unix, Win, Mac, Linux, IBM, Other
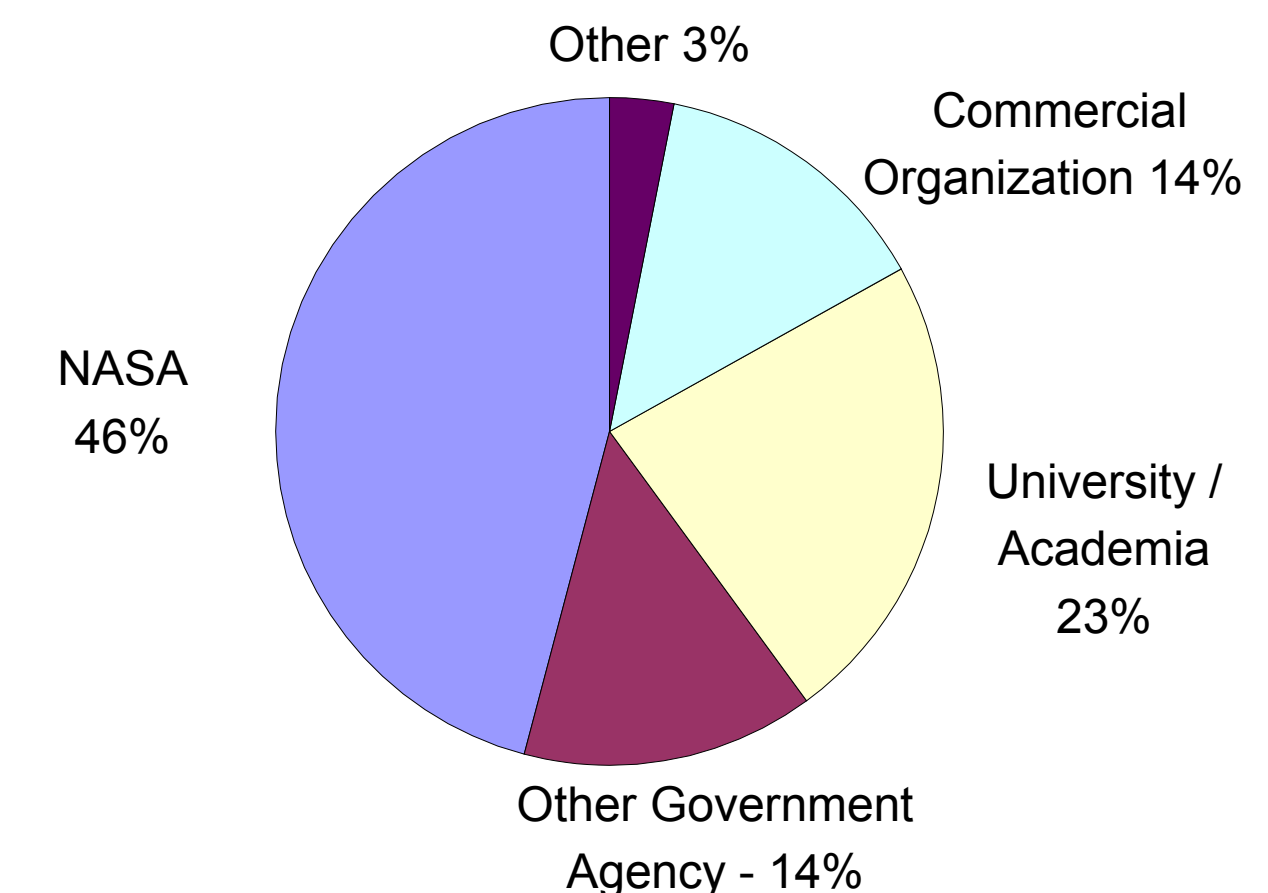
Programming Language(s) Used: C, C++, C#, Java, Perl, Pascal, Python, Fortran, Basic/VB, Web, Other

I. Reuse Experiences

Saving time was ranked as the primary motivation for reuse. Rated as either important or very important by 87.3% of respondents

1 (Not important at all)	(0)	0.0%
2 (Not very important)	(1)	1.3%
3 (Somewhat important)	(9)	11.4%
4 (Important)	(28)	35.4%
5 (Very important)	(41)	51.9%
Total	(79)	

Motivation For Reuse
Why reuse?
1. Saving time
2. Ensuring reliability
3. Saving money

(Saving money, Saving time, Ensuring reliability, Not having the expertise, Other)

Barriers to Reusing Software
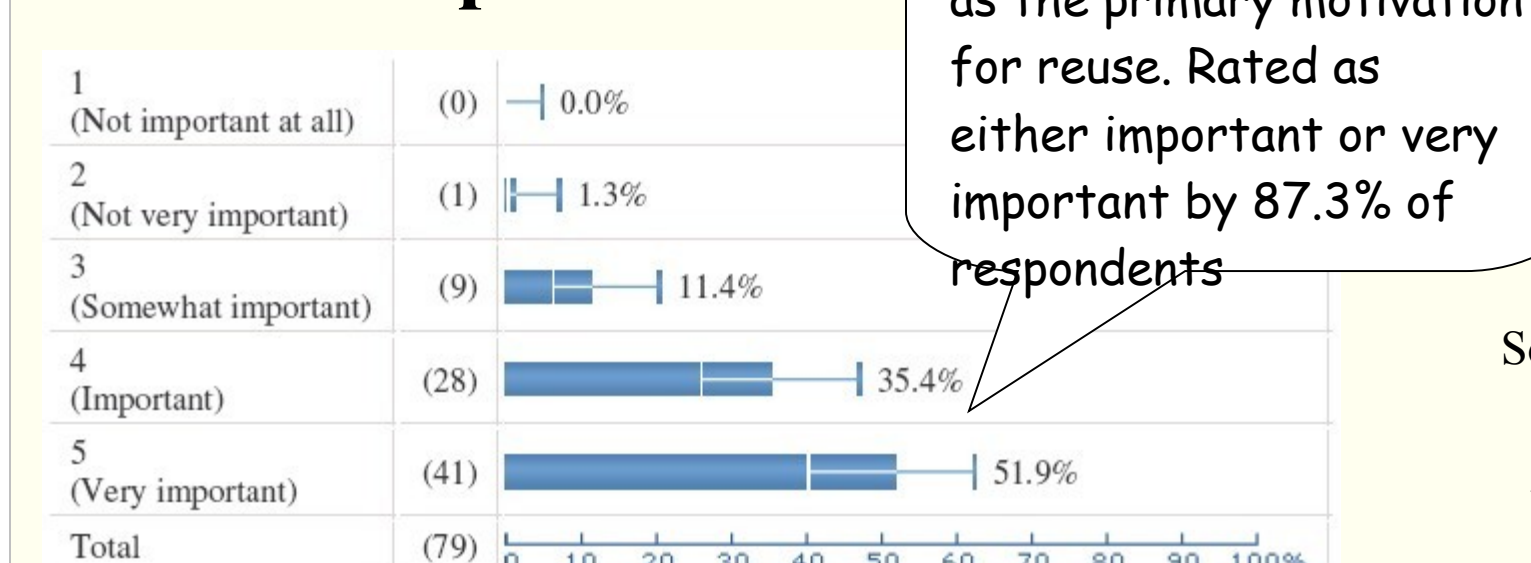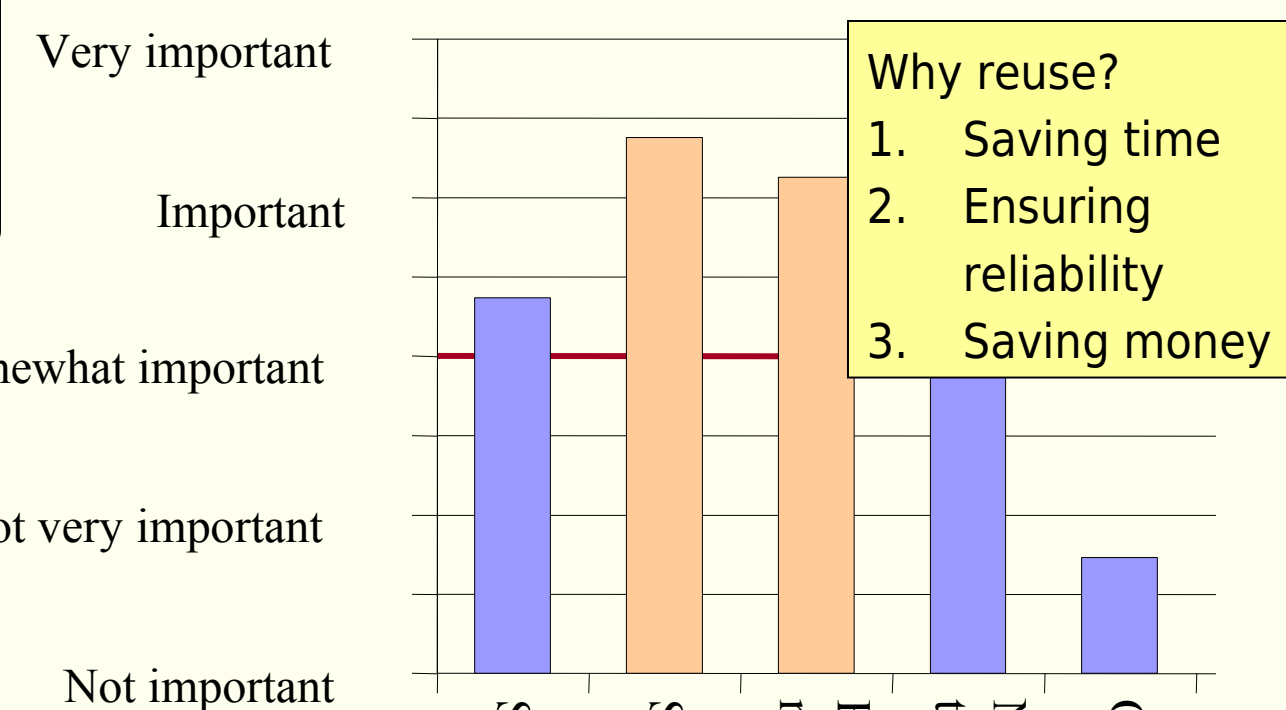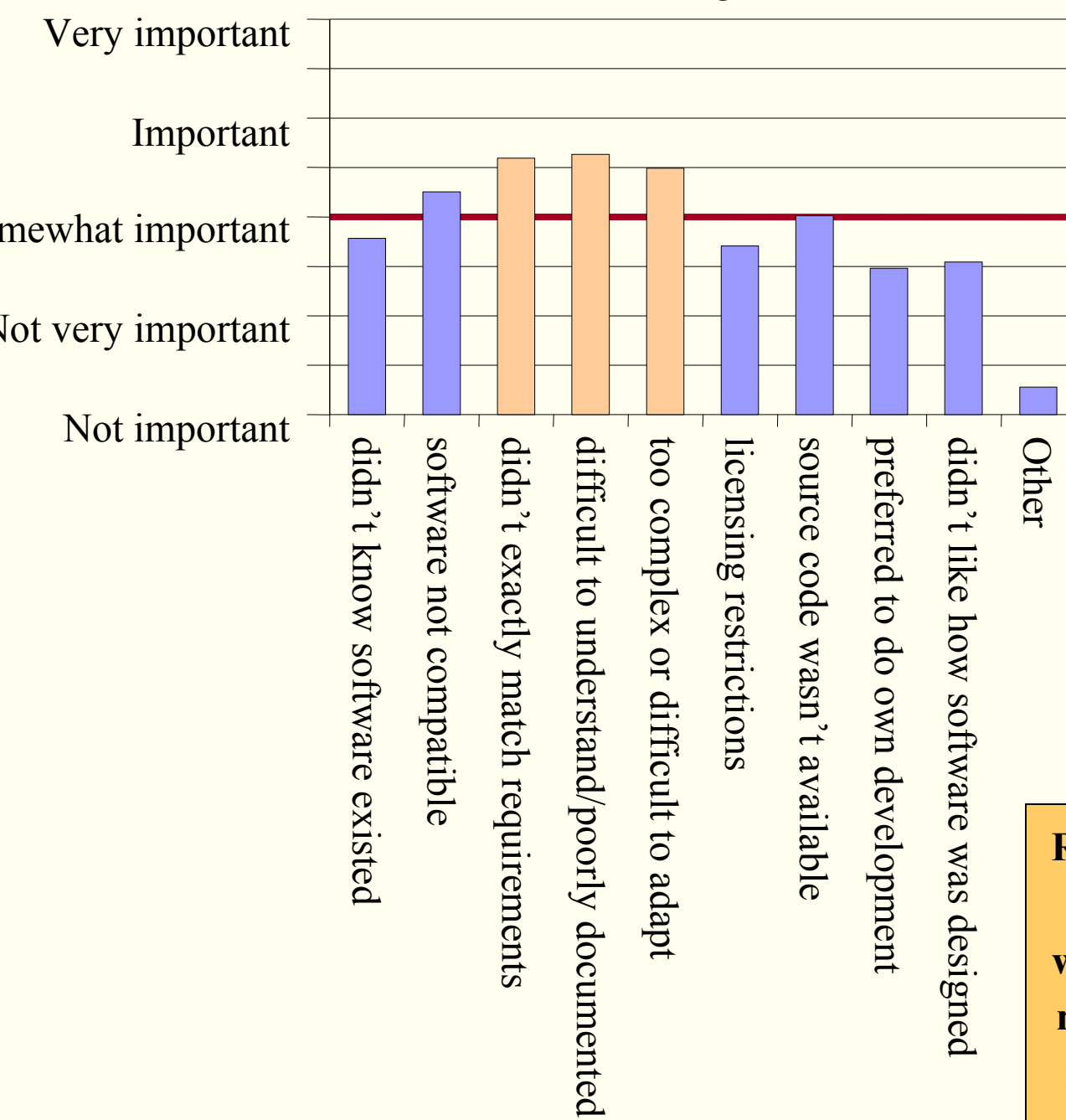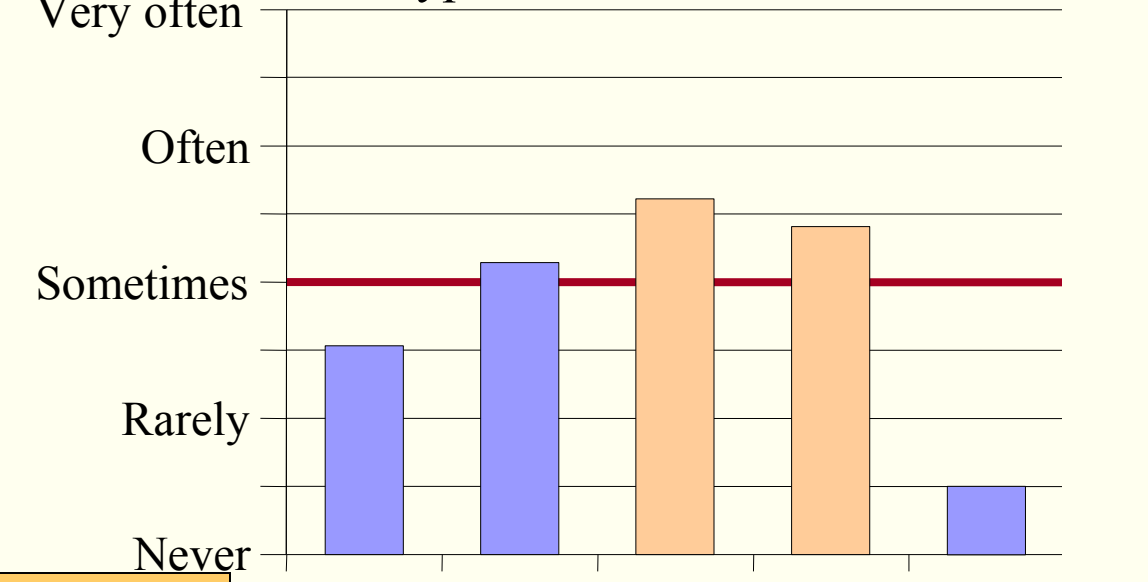didn't know software existed; software not compatible; didn't exactly match requirements; too complex or difficult to adapt; difficult to understand/poorly documented; licensing restrictions; source code wasn't available; preferred to do own development; didn't like how software was designed; Other

Types of Software Reused
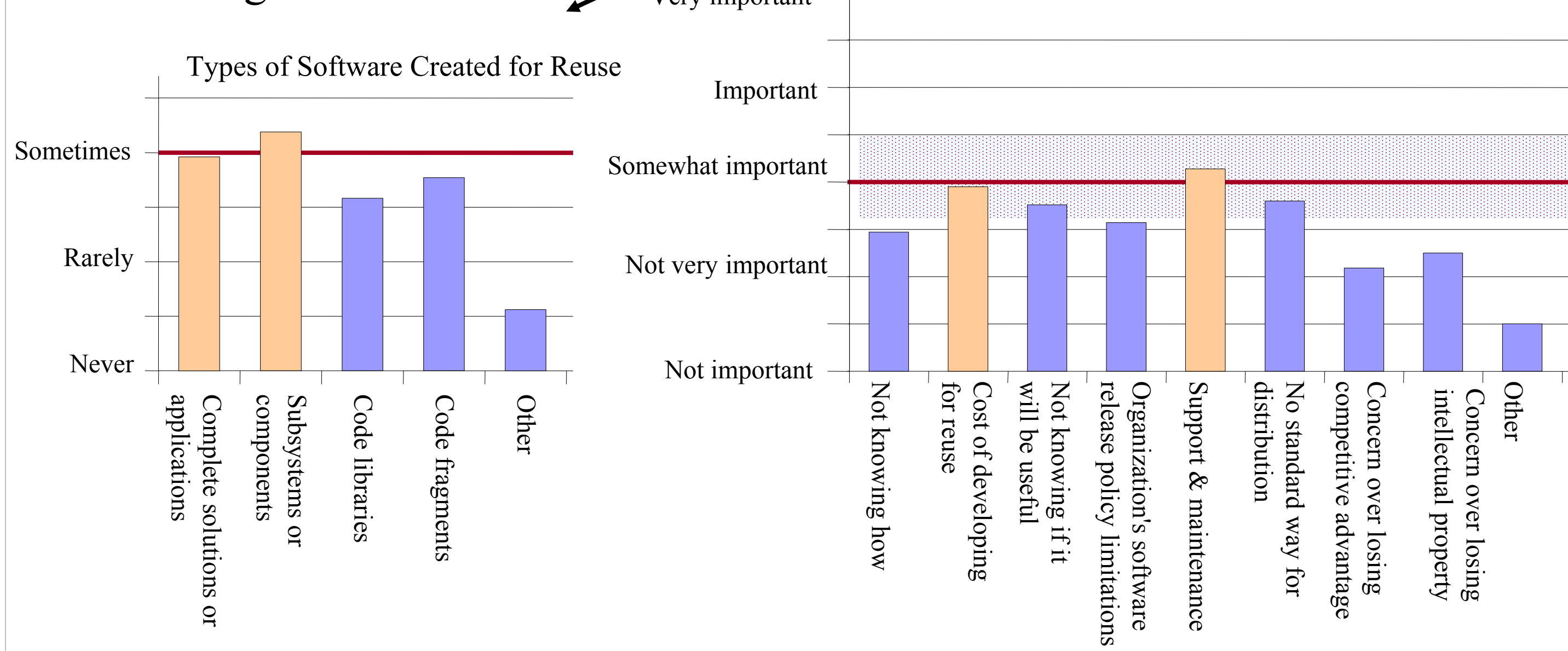Complete Systems; components; Sub-systems; Code libraries; Code fragments; Other

Reusers tend to favor the smaller units of code while the software that is made available for reuse is more often the larger units of code

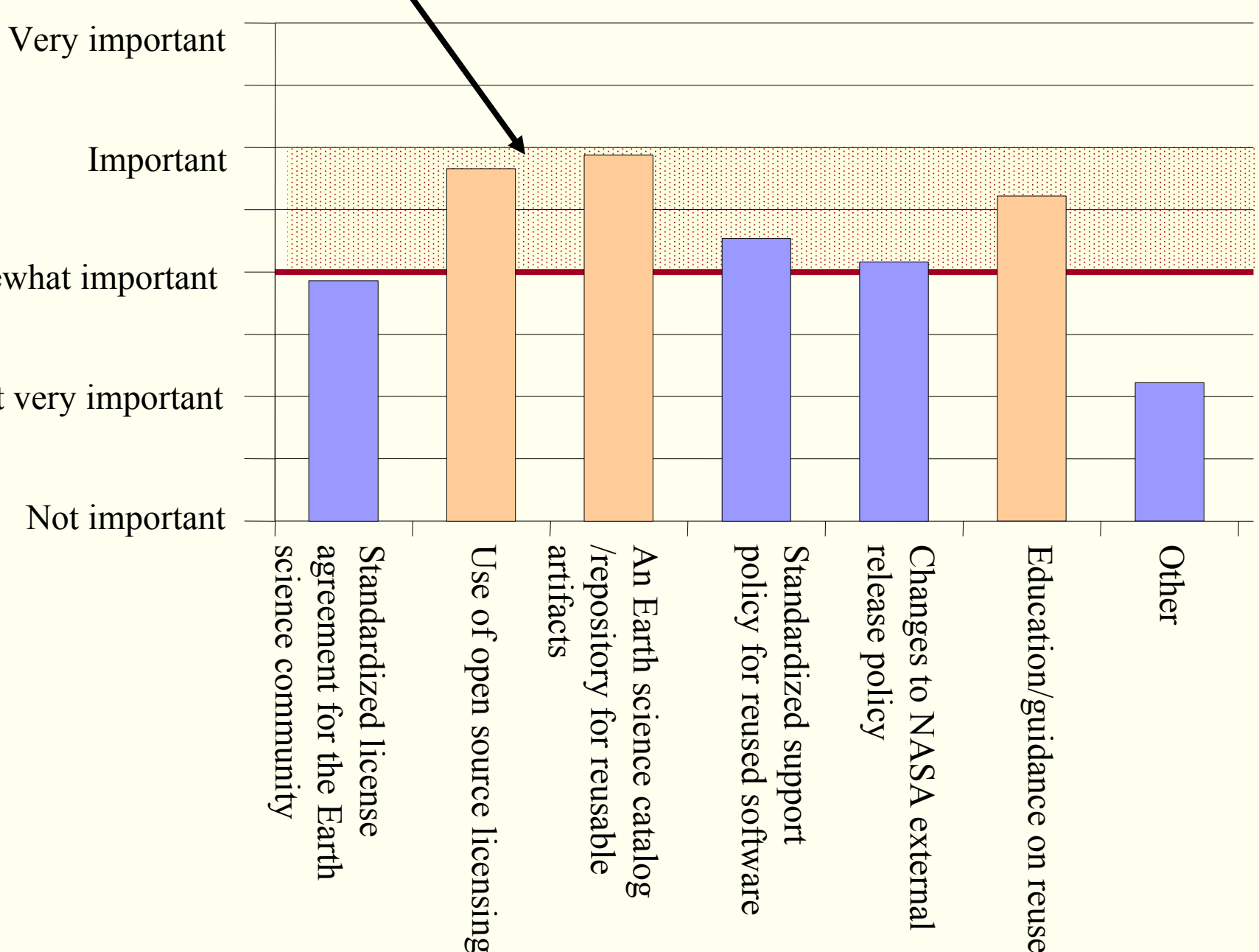## IV. Creating reusable software

Types of Software Created for Reuse
Complete solutions or applications; Subsystems or components; Code libraries; Code fragments; Other

Barriers to Making Software Available for Reuse
Not knowing how; Cost of developing for reuse; Not knowing if it will be useful; Organization's software release policy limitations; Support & maintenance; No standard way for distribution; Concern over losing competitive advantage; Concern over losing intellectual property; Other

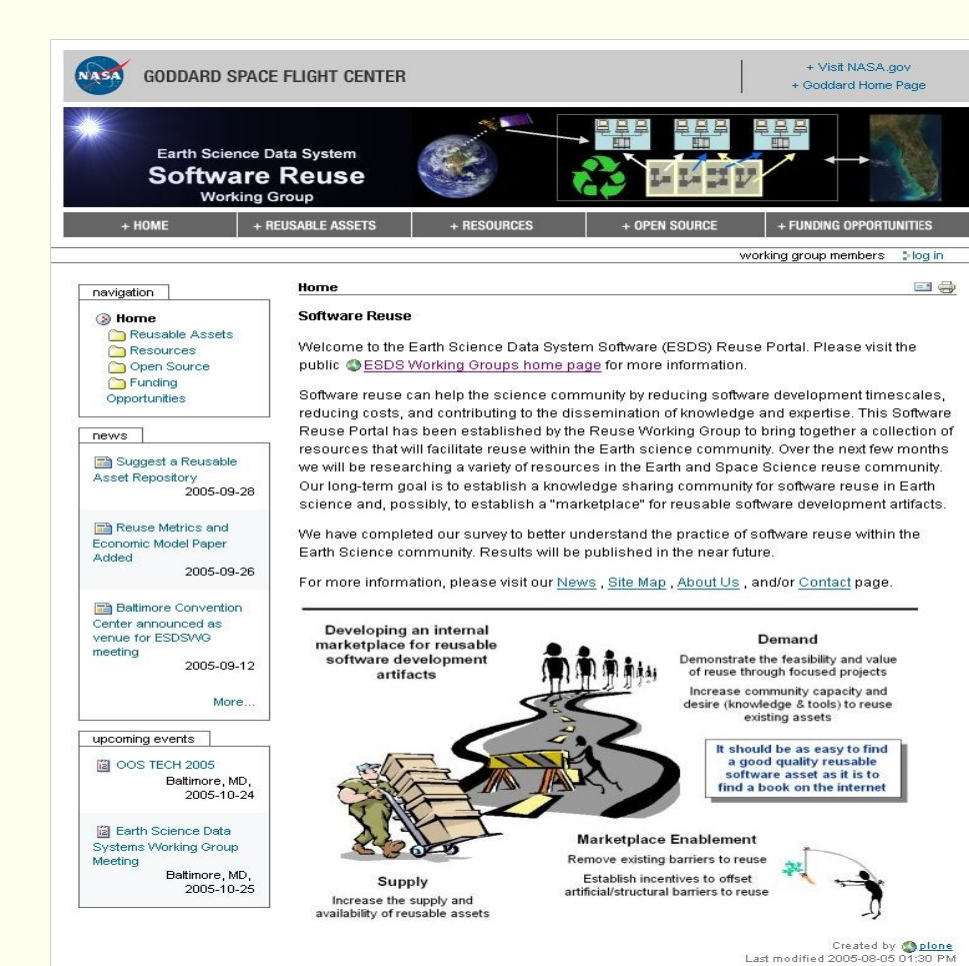## V. Increasing Software Reuse in the Earth Science Community

Greater use of open source licensing, a repository for Earth science artifacts, and education and guidance on reuse were identified as the most important factors in increasing the amount of reuse.

How to Increase Reuse
Standardized license agreement for the Earth science community; Use of open source licensing; An Earth science catalog /repository for reusable artifacts; Standardized support policy for reused software; Changes to NASA external release policy; Education/guidance on reuse; Other

The Earth Science Data Systems Reuse Working Group has establish a pilot reuse portal to:
- Raise awareness of software reuse within the Earth science community,
- Establish a platform for community members to share/exchange resources with each other,
- Be the gateway for reuse information relevant to the community,
- Make access to reuse resources easier, and
- Become the major starting site for reuse within the community

II. Software Functionality Sources

Existing software in the baseline system
None	(9)	11.4%
<5%	(2)	2.5%
5-15%	(20)	25.3%
15-50%	(27)	34.2%
>50%	(21)	26.6%
Total	(79)	

Newly written custom software
None	(2)	2.5%
<5%	(4)	5.1%
5-15%	(13)	16.5%
15-50%	(33)	41.8%
>50%	(27)	34.2%
Total	(79)	

Software reused from another part of your organization
None	(26)	32.9%
<5%	(9)	11.4%
5-15%	(17)	21.5%
15-50%	(21)	26.6%
>50%	(6)	7.6%
Total	(79)	

Software reused from another organization in the Earth science community
None	(15)	19.0%
<5%	(24)	30.4%
5-15%	(24)	30.4%
15-50%	(14)	17.7%
>50%	(2)	2.5%
Total	(79)	

Software reused from outside the Earth science community
None	(28)	35.4%
<5%	(25)	31.6%
5-15%	(16)	20.3%
15-50%	(4)	5.1%
>50%	(6)	7.6%
Total	(79)	

Commercial components
None	(27)	34.2%
<5%	(24)	30.4%
5-15%	(14)	17.7%
15-50%	(8)	10.1%
>50%	(6)	7.6%
Total	(79)	

Other
None	(25)	78.1%
<5%	(1)	3.1%
5-15%	(3)	9.4%
15-50%	(2)	6.2%
>50%	(1)	3.1%
Total	(32)	

III. Locating reusable software development artifacts

Personal knowledge from past projects
1 (Not important at all)	(0)	0.0%
2 (Not very important)	(3)	3.8%
3 (Somewhat important)	(16)	20.3%
4 (Important)	(34)	43.0%
5 (Very important)	(26)	32.9%
Total	(79)	

Word of mouth/networking
1 (Not important at all)	(1)	1.3%
2 (Not very important)	(6)	7.6%
3 (Somewhat important)	(17)	21.5%
4 (Important)	(39)	49.4%
5 (Very important)	(16)	20.3%
Total	(79)	

Google search or similar
1 (Not important at all)	(11)	13.9%
2 (Not very important)	(13)	16.5%
3 (Somewhat important)	(22)	27.8%
4 (Important)	(19)	24.1%
5 (Very important)	(14)	17.7%
Total	(79)	

Reuse catalog or repository
1 (Not important at all)	(40)	50.6%
2 (Not very important)	(17)	21.5%
3 (Somewhat important)	(13)	16.5%
4 (Important)	(7)	8.9%
5 (Very important)	(2)	2.5%
Total	(79)	

Authors: Olding, S W solding@everware.com, Everware
Delnore, V E v.e.delnore@nasa.gov, NASA Langley Research Center
Samadi, S shahin.samadi@gsfc.nasa.gov, NASA Goddard Space Flight Center
Wolfe, R E robert.e.wolfe@gsfc.nasa.gov, NASA Goddard Space Flight Center

http://softwarereuse.nasa.gov/